Final

INCREASED OIL PRODUCTION AND RESERVES UTILIZING SECONDARY/TERTIARY RECOVERY TECHNIQUES ON SMALL RESERVOIRS IN THE PARADOX BASIN, UTAH

(Contract No. DE-FC22-95BC14988)

TECHNICAL PROGRESS REPORT

Submitted by

Utah Geological Survey
Salt Lake City, Utah 84114-6100
May 2002

Contract Date: February 9, 1995
Anticipated Completion Date: August 31, 2005
Government Award (fiscal year): $137,072
Principal Investigator/Program Manager: Thomas C. Chidsey, Jr.

Contracting Officer's Representative/Project Manager

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Reporting Period: January 1 - March 31, 2002

DISCLAIMER

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Objectives

The primary objective of this project is to enhance domestic petroleum production by demonstration and technology transfer of an advanced oil recovery technology in the Paradox Basin, southeastern Utah. If this project can demonstrate technical and economic feasibility, the technique can be applied to about 100 additional small fields in the Paradox Basin alone, and result in increased recovery of 150 to 200 million bbl of oil. This project is designed to characterize five shallow-shelf carbonate reservoirs in the Pennsylvanian (Desmoinesian) Paradox Formation and choose the best candidate for a pilot demonstration project for either a waterflood or carbon dioxide-(CO_2-) flood project. The field demonstration, monitoring of field performance, and associated validation activities will take place in the Paradox Basin within the Navajo Nation. The results of this project will be transferred to industry and other researchers through a petroleum extension service, creation of digital databases for distribution, technical workshops and seminars, field trips, technical presentations at national and regional professional meetings, and publication in newsletters and various technical or trade journals.

Summary of Technical Progress

Implementation of Pilot Carbon Dioxide Flood Demonstration

Results from Budget Period I of this project showed that a carbon dioxide (CO_2) flood was technically superior to a waterflood and was economically feasible on typical small, shallow-shelf carbonate buildup reservoirs in the Paradox Basin.[1, 2] Based on the geologic characterization study, reservoir performance predictions, and the associated economic assessment of implementing a CO_2 flood in the Anasazi field, San Juan County, Utah (Fig. 1), an optimized CO_2 flood is predicted to recover 4.21 million STB of oil. This represents an increase of 1.65 million STB of oil over predicted primary depletion recovery at January 1, 2012. If the CO_2 flood performs as predicted, it is a financially robust process for increasing the reserves of the Anasazi field and similar small fields in the basin.

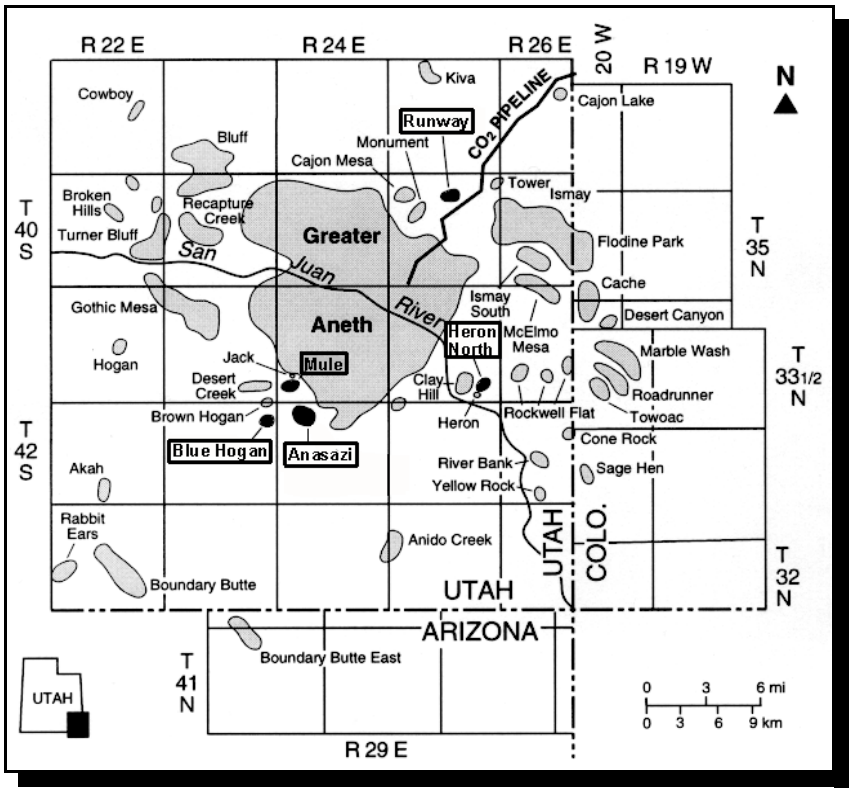

Figure 1. Location of Anasazi field (dark shaded area with name in bold type) and CO_2 pipeline to the Greater Aneth field area in the southwestern Paradox Basin on the Navajo Nation, San Juan County, Utah.

Budget Period II of the project involves the implementation of a pilot CO_2-flood demonstration on Anasazi field. The field demonstration includes: conducting a CO_2 injection test(s), obtaining a CO_2 source and fuel gas for the compressor, rerunning project economics, drilling a development well(s) (vertically or horizontally), purchasing and installing injection facilities, monitoring field performance, and validation and evaluation of the techniques. The demonstration will prove (or disprove) CO_2-flood viability, and thus help determine whether the technique can be applied to the other small carbonate buildup reservoirs in the Paradox Basin. Obtaining a CO_2 source is the key to beginning this demonstration.

In December 1999, the Utah Geological Survey (UGS) requested a three year, no-cost extension for Budget Period II of the project. Obtaining a CO_2 source is the key to beginning this demonstration. At the time of the request, there was only one CO_2 source in the area, a pipeline (Fig. 1) which is now owned and operated by ExxonMobil (formerly Mobil Oil Corporation). The CO_2 line was operating at full capacity supplying CO_2 to wells on the north side of the San Juan River as

part of a large CO_2 flood of the giant Greater Aneth field. In 2001, about 15.5 BCF of CO_2 was injected into the Desert Creek reservoir (Paradox Formation) in the field.[3] During the year, monthly injection of CO_2 averaged 0.4 BCF. Plans to expand the pipeline capacity and extend it south across the river, closer to Anasazi field, were delayed about a year and a half due to low oil prices in 1998 and early 1999, and a backlog of higher priority projects by the operators of Greater Aneth field. These factors combined with uncertainty over the merger of Mobil and Exxon resulted in a delay in the availability of CO_2 to Anasazi field for at least two years. Thus, the extension was granted so that Budget Period II would end August 31, 2005.

All project fields (Anasazi, Blue Hogan, Heron North, Mule, and Runway; Fig. 1) operated by the Utah Geological Survey's industry partner, Harken Energy Corporation, have been sold to the Rim Energy Companies of Denver, Colorado. The CO_2 pipeline has now been extended south of the San Juan River to other parts of Greater Aneth field and further expansion is in the planning stages. Rim is currently having difficulty obtaining APDs and approved right-of-ways due to assignability problems with the Navajo Nation, the land owners. The field demonstration (pilot CO_2 flood) requires three years - one year to implement and two years of monitoring and evaluation. In order for this to be achieved by 2005, the project needs to begin now. This will not happen under current conditions. The UGS has no contract with the current field operator, Rim. Rim has expressed interest in performing the demonstration but makes no guarantees and considers current oil prices too low, nor can they predict when, if ever, their problems with the Navajo Nation will be resolved.

The UGS is left with the following options:

1. continue to extend the project indefinitely in hopes the operator will work things out with the Navajo Nation in addition to desiring to participate in the demonstration project once that occurs, and

2. seek out other operators of similar fields outside of the Navajo Nation and who are willing to cost-share the demonstration project.

The problem with option 2 is that the UGS will have not conducted any reservoir characterization, modeling, or CO_2 flood simulation on those fields. The project was originally designed to perform such tasks and prove the predictions with the field demonstration. Carbon dioxide sources could also be a problem as there is still only the one pipeline in the region (operators would have to drill for CO_2 without the benefit of knowing whether a CO_2 flood has been successful in similar fields, i.e. the original intent of the project).

The Utah Geological Survey will continue to carefully monitor the CO_2 availability situation. In addition, ExxonMobil has expressed interest in working with Rim and the UGS to tie Anasazi field into their CO_2 pipeline infrastructure. Most operators in the basin are small independent companies that need to see a successful and economically viable CO_2-flood demonstrated on a small field before they will invest in CO_2 acquisition, new pipelines, injection wells, and additional field facilities. However, a few operators of fields similar to Anasazi have indicated they would consider conducting the CO_2-flood project on their fields should funding from the DOE be available, and if current problems continue to prevent the demonstration from occurring at Anasazi field.

Technology Transfer

Activities conducted this quarter consisted of displaying project material at the Utah Geological Survey (UGS) booth during the American Association of Petroleum Geologists (AAPG) annual convention held in Houston, Texas, March 10 through 13, 2002.

The project home page on the UGS Internet web site (http://geology.utah.gov/emp/PARADOX/index.htm) was updated with the latest quarterly technical report and project publications list.

References

1. T. C. Chidsey, Jr., and M. L. Allison, Increased Oil Production and Reserves Utilizing Secondary/Tertiary Recovery Techniques on Small Reservoirs in the Paradox Basin, Utah, *Annual Report*, DOE Contract No. DE-FC22-95BC14988, DOE/BC/14988-10 (DE98000493), July 1998.

2. T. C. Chidsey, Jr., D. E. Eby, D. M. Lorenz, and W. E. Culham, Increased Oil Production and Reserves Utilizing Secondary/Tertiary Recovery Techniques on Small Reservoirs in the Paradox Basin, Utah, *Annual Report*, DOE Contract No. DE-FC22-95BC14988, DOE/BC/14988-12 (OSTI ID: 14245), November 1999.

3. Lisha Cordova, 2002, *Utah Annual Injection Report 2001*, Utah Division of Oil, Gas and Mining, in preparation.

Next Quarter Activities

Activities planned for the next quarter (April 1 through June 30, 2002) include:

1. Discuss with DOE Project Manager the status of the Rim Energy Companies and determine interest in continuing the time allotted to begin the pilot demonstration project.

2 Monitor CO_2 availability for Anasazi field or other pilot flood project.

3. Continue preparation of a digital catalog of basic pore types and report of diagenetic history of reservoirs based on thin sections from project fields.

4. Update project home page on the UGS Internet web site.